



# Solid State Power Amplifiers

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## *At a Glance*

### What is it?

- Solid state power amplifiers provide compact Radio Frequency (RF) power gain and amplification through microelectronic-based device technologies.

### How does it work?

- Semiconductor transistors designed for microwave and higher frequency RF operation are incorporated into microelectronic-based circuits which include all the required RF components such as transmission lines and capacitors resulting in a low-cost, high performance Monolithic Microwave (or mm-Wave) Integrated Circuits (MMIC) technologies.

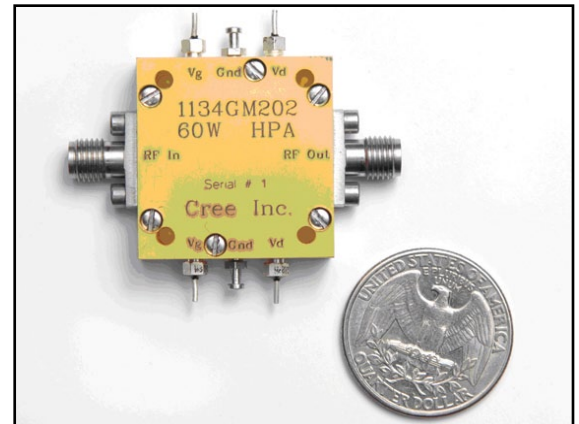
### What will it accomplish?

- MMIC technology enables compact, low-cost, efficient RF amplifiers for space- and power-constrained platforms, and is an enabling technology for the widespread application of Active, Electronically-Scanned Array (AESA) antennas.

### Points of Contact

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**G**allium Nitride (GaN) presents a significant opportunity to advance solid state RF power amplifiers due to the very high electric field breakdown (~10x) for this material, which translates into higher voltage operation and output impedance for GaN-based High Electron Mobility Transistor (HEMT) MMIC technology. The development of GaN technology has been largely achieved by exploiting Office of Naval Research science and technology investments over many decades in semiconductor compound III-V materials and devices.



The current commercially available technologies such as Silicon- and Gallium Arsenide-based MMIC are limited in power output and efficiency, as well as frequency performance. GaN HEMT technology and device physics offers unique advantages in the areas of high electric breakdown field, power density, and low on-resistance, which translates into devices that are more easily RF impedance-matched for advanced broadband amplifier performance and linearity. Secondly, the high frequency properties make this technology an almost perfect RF switch. This has enabled the demonstration of S-Band switched-mode amplifiers that have achieved 70 percent power added efficiency in GaN HEMT MMICs.

Large Navy shipboard radar arrays consume significant amounts of electrical power, and require significant cooling infrastructure to mitigate amplifier DC to RF electrical conversion inefficiencies. Improvements in electrical efficiency directly impact acquisition and life-cycle cost of for sea-based AESAs. High-performance broadband amplifiers will enable multi-signal, multi-function apertures and will reduce the required antenna real estate necessary for control of the electromagnetic battlespace.

### Research Challenges and Opportunities:

- Current S&T research challenges are focusing on wide bandgap materials such as Gallium Nitride and related group III-Nitrides, along with emerging solid state technologies in order to advance new transistor technologies for solid state power amplification.
- Ultra-high efficiency amplification (DC to RF conversion efficiency) is required where power consumption and thermal considerations due to power dissipation render existing COTS solutions impractical from an overall platform affordability perspective.
- Very broadband and highly linear amplifiers are required for shared RF aperture approaches to reduce the proliferation of single function antennas that currently clutter Navy platforms.

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